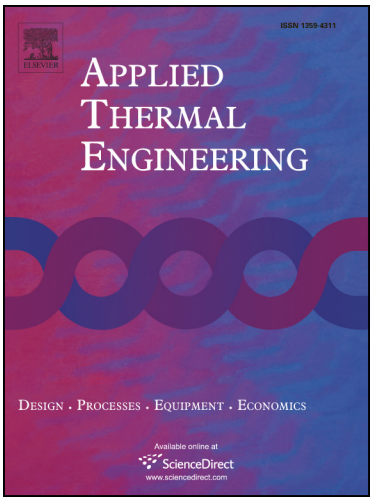

Research Paper

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Spray cooling for high temperature of exhaust gas using a nozzle array in a confined space: Analytical and empirical predictions on cooling capacity

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ABSTRACT

High-temperature exhaust gas generated from turbines is a common issue among industrial applications. A wet system, e.g., spray cooling, can be an effective way to decrease the temperature, especially in limited spaces when ventilation can be ineffective. In this paper, the performance of water spray cooling on high-temperature (above 450 °C) exhaust gas using a 4×4 nozzle array, which consists of eight pressure-type spiral nozzles (PN) and eight impinging-type nozzles (IN), in a confined chamber was investigated. A standard procedure was developed to perform spray cooling tests at three back pressures (BPs), i.e., 0.5 MPa, 1.0 MPa and 1.5 MPa. Four cross-sections were dedicated to measure dry-bulb temperature and one of them can report wet-bulb temperature, all in real time. The results show that, first, spray cooling can decrease the temperature of exhaust at the four sections by approximately 10 ~ 100 °C, depending on working nozzles' row and flowrate. The position of working nozzles has a significant impact on the cooling effects near the exhaust outlet, but not for the distant sections since the air and the exhaust can be better mixed. Second, both types of nozzles have similar correlations between BPs and flowrates. However, it is easier for IN to contribute to humidity ratio increment due to better atomization at higher BPs. As a result, the moist air during IN tests was prone to get saturated and significantly compromised the ability of evaporative cooling. Third,